ELSEVIER
Available online at www.sciencedirect.com
SciVerse ScienceDirect
Physics Procedia 24 (2012) 769 – 773
Physics Procedia

2012 International Conference on Applied Physics and Industrial Engineering

Human-computer Interaction System Based on GRBF & HMM

Wang Juan

The Chinese People's Armed Police Forces Academy, Langfang ,Hebei,China
Yanshan university,Qinhuangdao,Hebei,China

Abstract

People have made many researches on computer vision, but the accuracy and speed were not satisfactory. This paper introduced a Human-computer interaction system based on GRBF and HMM. The paper used GRBF Artificial Neural Networks define the position of head, and HMM define the position of fingers. We combined the line of sight and the direction of fingers to ensure the uses' input focus. And the results showed that the recognition accuracy and speed of the system had been increased greatly in this way.

Keywords: HMM; GRBF; Human-computer interaction

1.Introduction

With the development of computer vision technology, people had studied a lot of human-computer interaction methods to replace the mouse, keyboard, and etc. Bennew[1] introduced a method of mobile robot navigation in dynamic environments; Guo Kangde[2] had proposed a real time human-computer interaction(HCI) based on hand gesture, he believed that since the 3D position of fingertip can be tracked and located through stereovision technology with two cameras and the real-time interaction between fingertip and 3D objects in virtual world can be achieved; Qian Kun[3] introduced a human motion activity recognition based on the abstract hidden Markov model, in which the decision making process of agent was equivalent to an abstract Markov decision process; Kazuyo I[4] proposed a line sight tracking system, in which the position of pupilla and eyepit determined the line sight direction.

The greatest characteristic of Human-computer interaction is highly real-time and accuracy, so the computer vision technology should meet the requirements of speed and accuracy. The paper introduced a Human-computer interaction system based on Gaussian Radial Basis Function (GRBF) and Hidden Markov Model (HMM), in which it combined the line of sight and the direction of fingers to ensure the uses' input focus.

1875-3892 © 2011 Published by Elsevier B.V. Selection and/or peer-review under responsibility of ICAPIE Organization Committee.
Open access under CC BY-NC-ND license. doi:10.1016/j.phpro.2012.02.114

2.The Principle of Human-computer interaction System

The paper proposed artificial neural network to define the position of head. The steps were as follows:

- First, detect the area of face in the image by cascade complexion separator;
- Second, fix the corresponding point in the area of face;
- Finally, extract characteristic value from the processed head grayscale image. Input learning and training neural network, and then calibrate the vertical and horizontal Angle by comparing and evaluating the results to determine the line of sight.

The paper introduced Hidden Markov Model, which was widely used in the field of speech recognition, to determine the direction of fingers. In interaction, finger keep stages of the pointing finger were our interest, so we used HMM model to separate this stage and calibrate the direction of fingers accurately.

When view Angle and pointing finger Angle is determined, we confirmed the point of intersection in the coordinate system, and then controlled target equipment to response by computer processing. In this way, we could realize human-machine interaction.

3.Algorithm descriptions

3.1.GRBF Artificial Neural Networks

Because the head orientation recognition was a highly nonlinear problem, we used Gaussian Radial Basis Function neural network. Figure 1 showed the GRBF neural network structure.

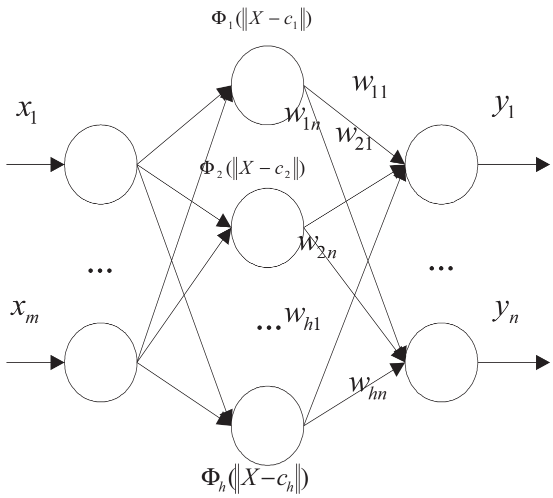

Figure.1 GRBF network structure

$X=(x_1,x_2,\cdots,x_m)^T$ was the input vector, which was composed by Source nodes. We extracted eight values as the eigenvalue of head such as distance between the eyes, the position of nose and mouth, etc. After a change processing, this eigenvalue was token as input vector of the neural network.

3.2.GRBF network learning algorithm

GRBF network learning algorithm needs to solve three parameters: the center of basic function, variance and weights between implicit and output layer.

- Find the center of basic function c based on K-means clustering method

  a) Network initialization

  Select h a training samples as clustering center c_i （i=1， 2， ⋯， h）.

  b) Group the input of training data according to the nearest neighbor rules.

  Assign x_p to different clustering set $\vartheta_p\,(p = 1,2,\cdots,p)$ according to the Euclidean distance between x_p and c_i.

  c) Readjust clustering center

  Calculate the training sample's average value in various clustering sets ϑ_p, namely the new clustering center c_i. If the new clustering center no longer changes, c_i is the final function center of GRBF networks, otherwise returns (b), and enters the next round.
  Iterations n of the algorithm meets the following conditions:

$$n \geq \frac{s \cdot \ln 10}{-\ln((1-\eta)\cdot I\{i = i(x_k)\} + I\{i \neq i(x_k)\})} \tag{1}$$

- Solving variance σ_i

$$\sigma_i = \frac{c_{\max}}{\sqrt{2h}}, i = 1,2,\cdots,h \tag{2}$$

  In (2), $c_{\max}$ is the maximum distance between the centers.

- Calculating
  We could get weights between implicit and output layer by using least-square method, and the formula is as follows:

$$w = \exp(\frac{h}{c_{\max}^2}\left\|x_p - c_i\right\|^2) \tag{3}$$

  In (3), p=1,2, ⋯,p; i=1,2,⋯,h.

-

3.3.Basic theories of hidden markov model

A hidden Markov model (HMM) is a statistical Markov model in which the system being modeled is assumed to be a Markov process with hidden states. An HMM can be considered a generalization of a mixture model where the hidden variables, which control the mixture component to be selected for each observation, are related through a Markov process rather than independent of each other.To define hidden Markov model, the following probabilities have to be specified: matrix of transition probabilities A=(aij), aij= P(si | sj) , matrix of observation probabilities B=(bi (vm)), bi(vm) = P(vm | si) and a vector of initial probabilities π=(πi), πi = P(si) . Model is represented by M=(A, B, π).

According to the state transition types, HMM can be divided into ergodic and left-right. Ergodic means the state transition is arbitrary, and it can arrive at itself and all other states; left-right means the state transition is limited to itself and the next state. According to the characteristic of hand movement, we used HMM to determine pointing fingers' hold stage and direction. We divided hand pointing process into three stages: begin, hold and end. We established HMM for the three stages respectively, and the topology of state sets was shown in figure 2.

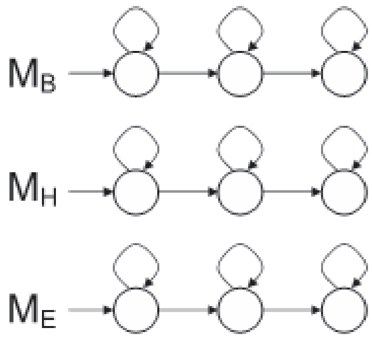

Figure 2. HMM state set topology (Begin,Hold,End)

Algorithm process was as follows:

- Initialization：

$$\sigma_1(i) = \pi_i b_i(O_1), 1 \le i \le N \tag{3}$$

$$\psi_1(i) = 0, 1 \le i \le N \tag{4}$$

- Iteration：

$$\delta_t(j) = \max_{0\le i\le 1}[\delta_{t-1} a_{ij}] b_j(O_t), 1 \le j \le N \tag{5}$$

$$\psi_t(j) = \arg\max_{0\le i\le 1}[\delta_{t-1} a_{ij}], 1 \le j \le N, 2 \le t \le T \tag{6}$$

- End：

$$P(O, Q^* \mid \theta) = \max_{0\le i\le 1}\left[\delta_T(i)\right] \tag{7}$$

$$q_t = \arg\max_{0\le i\le N}[\delta_{t-1}(i) a_{ij}] \tag{8}$$

- Recollection, namely decoding process：

$$q_t = \psi_{t+1}(q_{t+1}), 1 \le t \le T-1 \tag{9}$$

4. Conclusion

The paper introduced a Human-computer interaction system based on Gaussian Radial Basis Function (GRBF) and Hidden Markov Model (HMM), in which it combined the line of sight and the direction of fingers to ensure the uses' input focus. And the results showed that the recognition accuracy and speed of the system had been increased in this way.

References

[1] Bennew itz M. Mobile RobotNavigation in Dynamic Environments. Ph.D Dissertation. Freiburg. Germany: University of Freiburg. Department of Computing, 2004.

[2] Guo Kangde, Zhang Mingmin, Sun Chao, Li Yang, and Tang Xing. 3D Fingertip Tracking Algorithm Based on Computer Vision.Journal of Computer Research and Development. 2010,47(6), 1013-10i19.

[3] QIAN Kun, MA Xu-Dong, DAIXian-Zhong. M otion Activity Recognition Based on Abstract H idden Markov M odel.PR&AI, 2009,22(3),433-439.

[4] Kazuyo I, Satoshi K, Kazuo T. Eye movement tracking type head mounted display for virtual reality system: evaluation experiments of a proto-type system[J]. Proceedings of the IEEE International Conference on Systems, Man and Cybernetics, 1994,1:13-18.

[5] Piero Zappi, Bojan Milosevic. Hidden Markov Model based gesture recognition on low-cost, low-power Tangible User Interfaces. Entertainment Computing, 2009 (1), 75–84

[6] D.Gonzàlez-Ortegan, F.J.Dìaz-Pernas .Real-time hands, face and facial features detection and tracking: Application to cognitive rehabilitation tests monitoring. Journal of Network and Computer Applications, 2010 (33), 447–466.

[7] BennewitzM. Mobile RobotNavigation in Dynamic Environments.Ph.D Dissertation. Freiburg. Germany: University ofFreiburg. Department of Computing, 2004.